Expression Cloning

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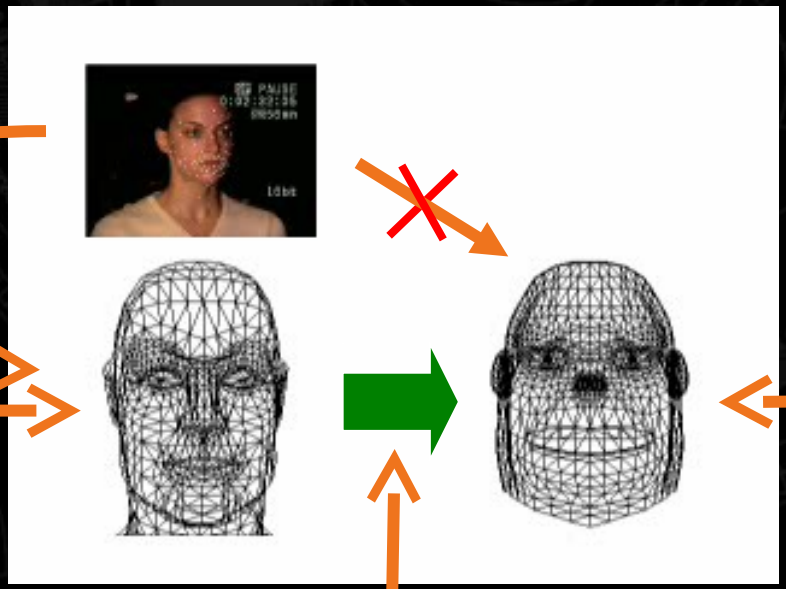
Research Goal

To efficiently duplicate available facial animation sequences onto different models by transferring vertex motion vectors



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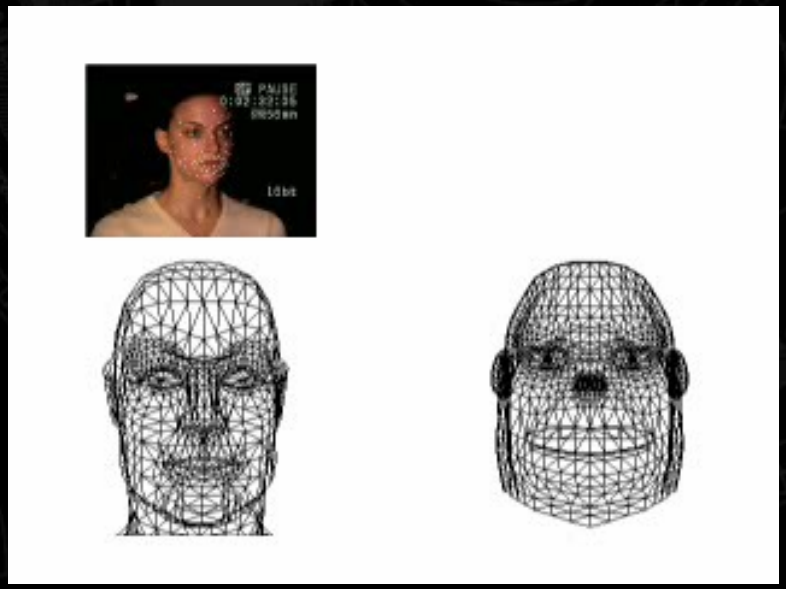
To efficiently duplicate available facial animation sequences onto different models by transferring vertex motion vectors



Expression animation cl
oning

Presentation Overview

- Related work on facial animation
- Dense surface correspondences
- Motion vector transfer
- Cloned expression animations
- Discussion and future work
- Summary

Related Work

- Parametric approach [Parke 1982]
- Physics based approach [Waters 1995][Lee 1995]
- Key framing [Pighin 1998][Lewis 2000]
- Performance driven animation [Williams 1990]
- Mpeg-4 [Ostermann 1998]

Limitations of Previous Work

- Parameters tuned for a specific model
- Repeated effort required for new models

Manual processes, computation, or artistic talent are repeatedly required even for similar animations on different models.

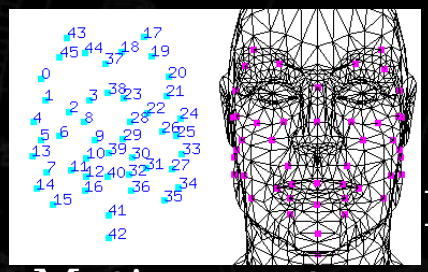
Advantages of Expression Cloning

- Semi-automatic process
- Real time performance
- Easy duplication of existing facial animations
- Preservation of original animation characters

Facial animation library compilation

Highly tuned models [Cohen 1993] + Cloning

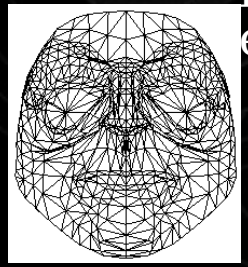
Expression Cloning System



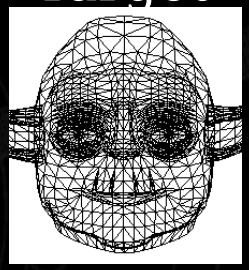
Source

Motion capture data or any animation mecha ism

Defor n



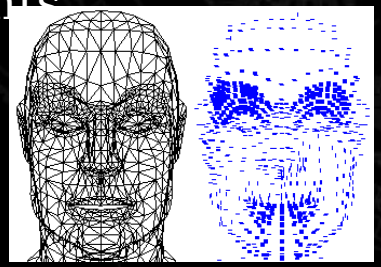
Dense surface correspo e es



Target

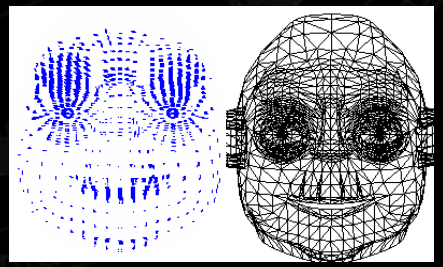
Cloned expressio ns

Vertices displaceme nts



Source animation

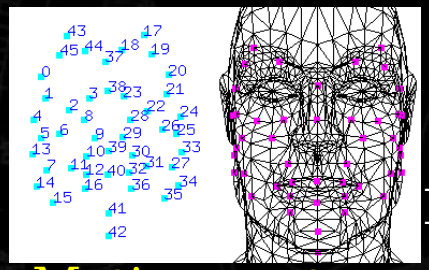
Motion transfer



Target animation

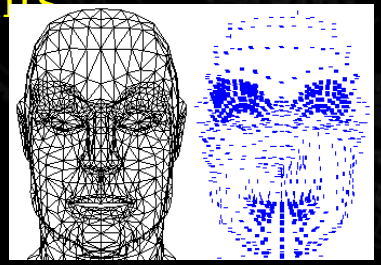
Source Animation Creation

Source



Motion capture data or any animation mecha ism

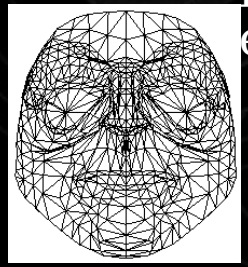
Vertices displaceme nts



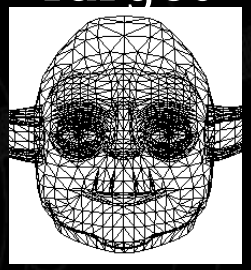
Source animation

Defor n

Dense surface corresp e es

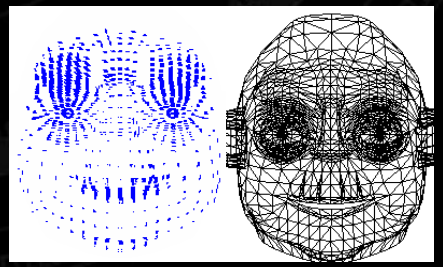


Target



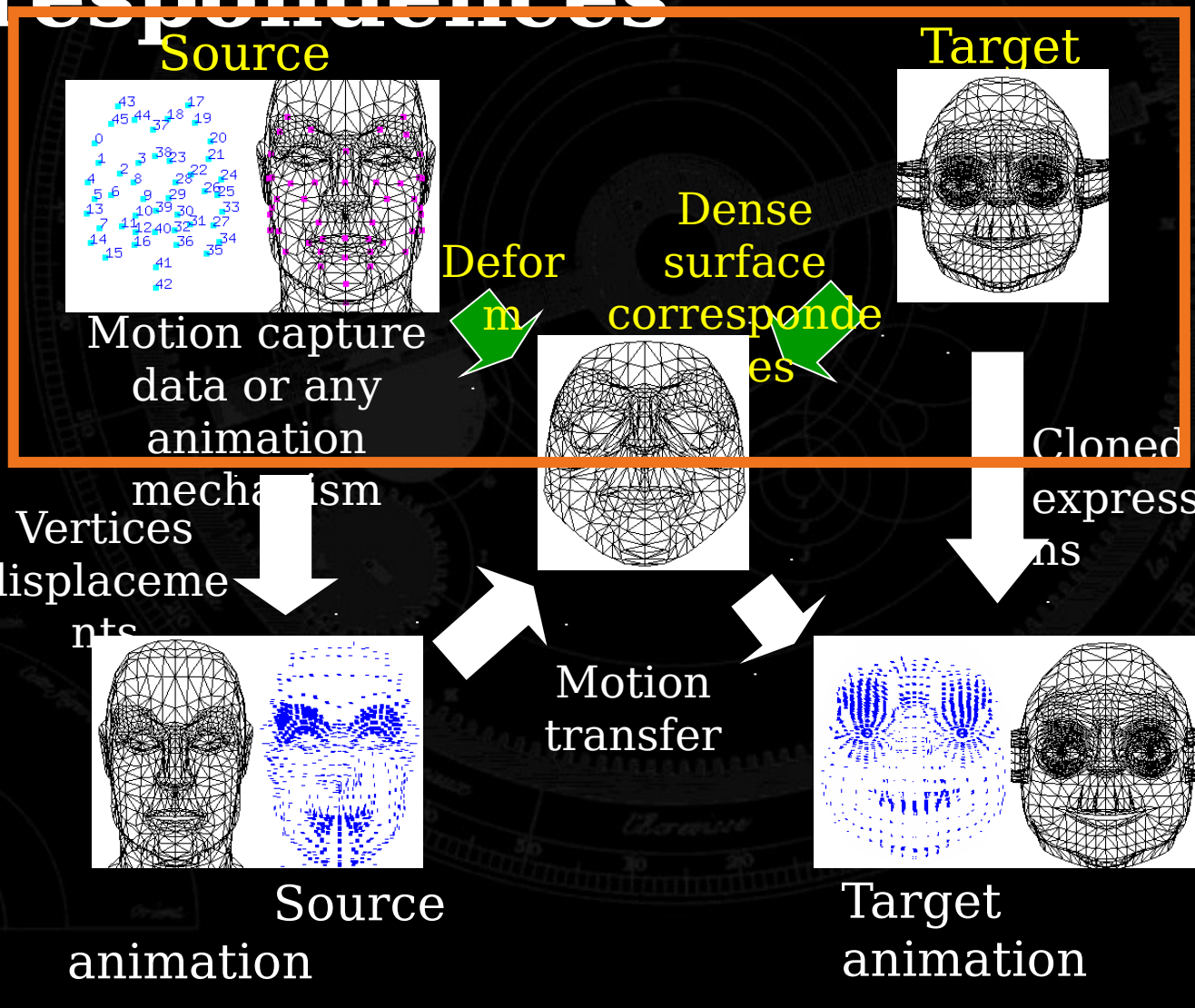
Cloned expressio ns

Motion transfer

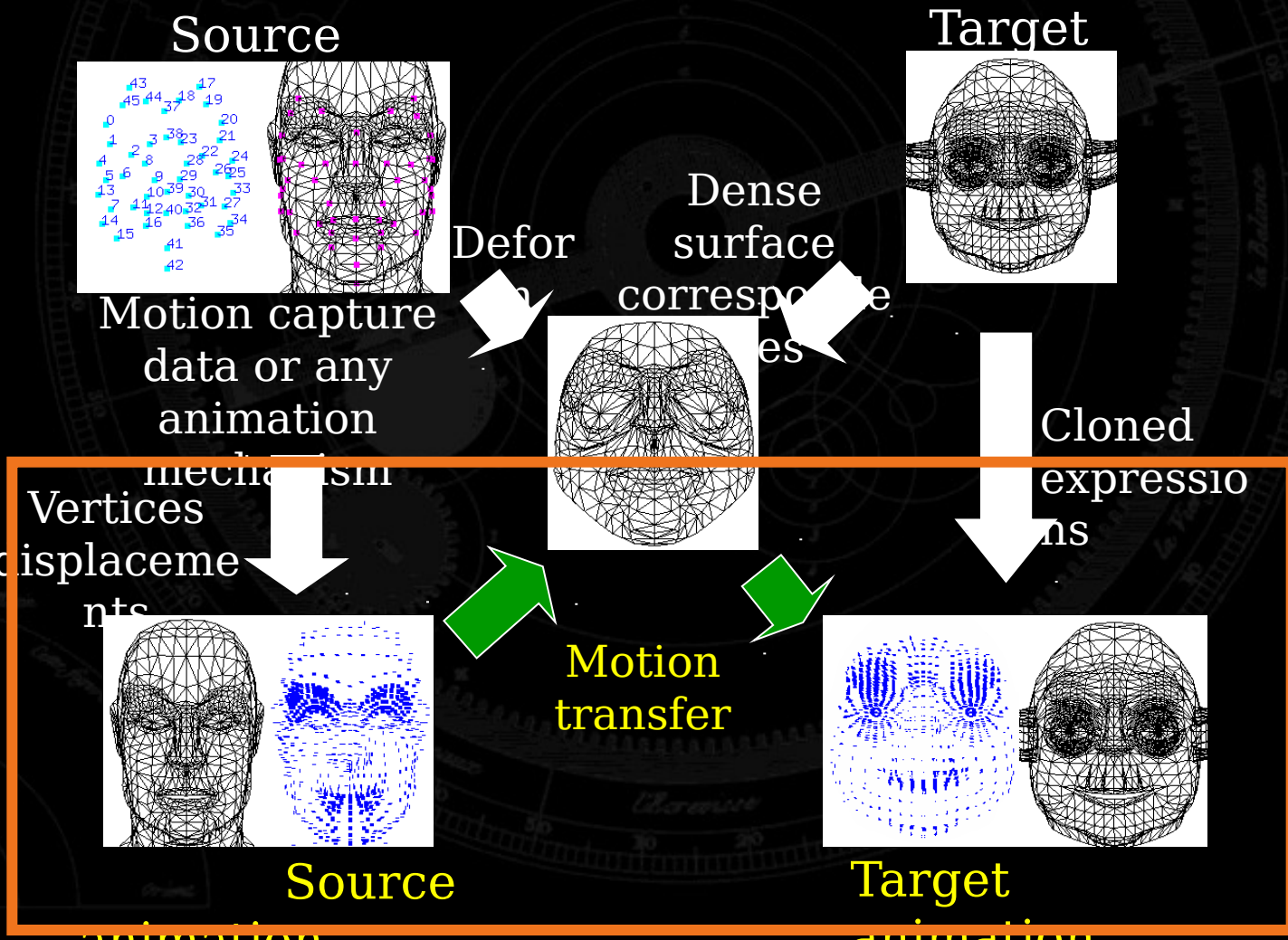


Target animation

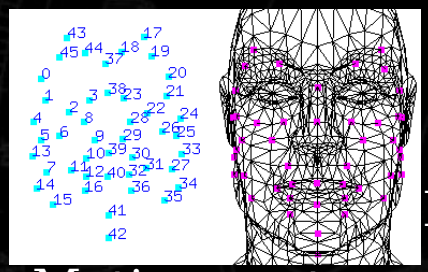
Dense Surface Correspondences



Motion Vector Transfer



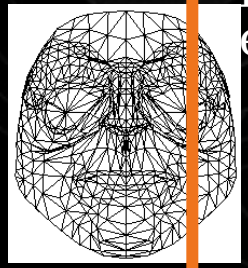
Cloned Expressions



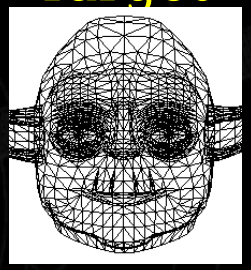
Source

Motion capture data or any animation mecha ism

Defor n



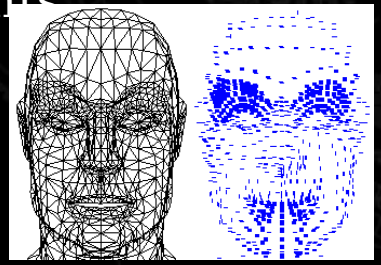
Dense surface corresp e es



Target

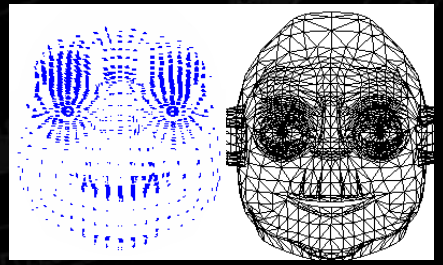
Cloned expressio ns

Vertices displaceme nts



Source animation

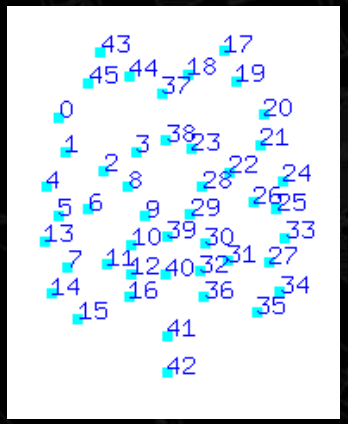
Motion transfer



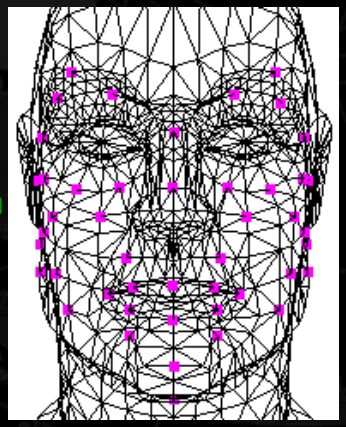
Target animation

Source Animation Creation

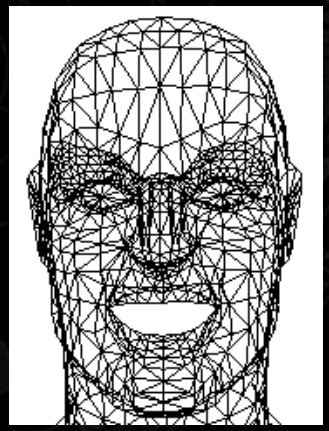
- Any available facial animation methods
- Motion capture data [Guenter 1998]



Motion capture data



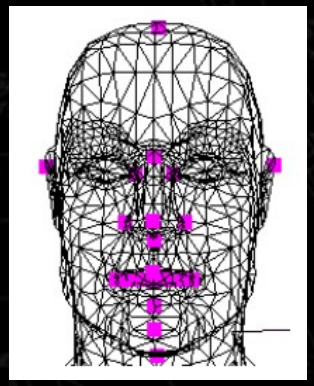
Source model



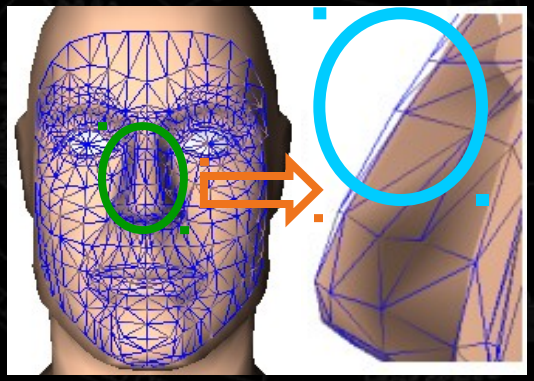
Source animation

Dense Surface Correspondences

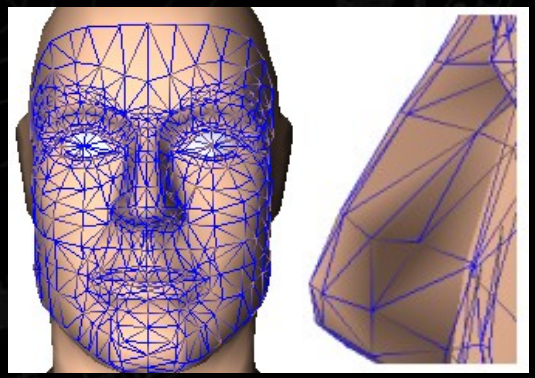
- Initial feature correspondence (15~35 points)
- Morphing with radial basis function
- Cylindrical projection



Initial Features



After RBF



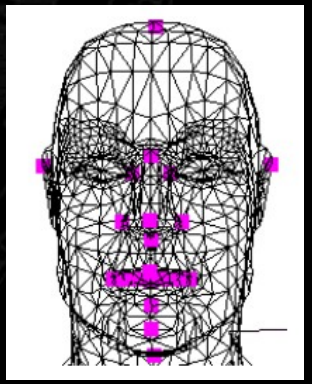
After projection

Initial Feature Search Rules

- Bootstrapping whole expression cloning process
- Exploiting typical human face geometry

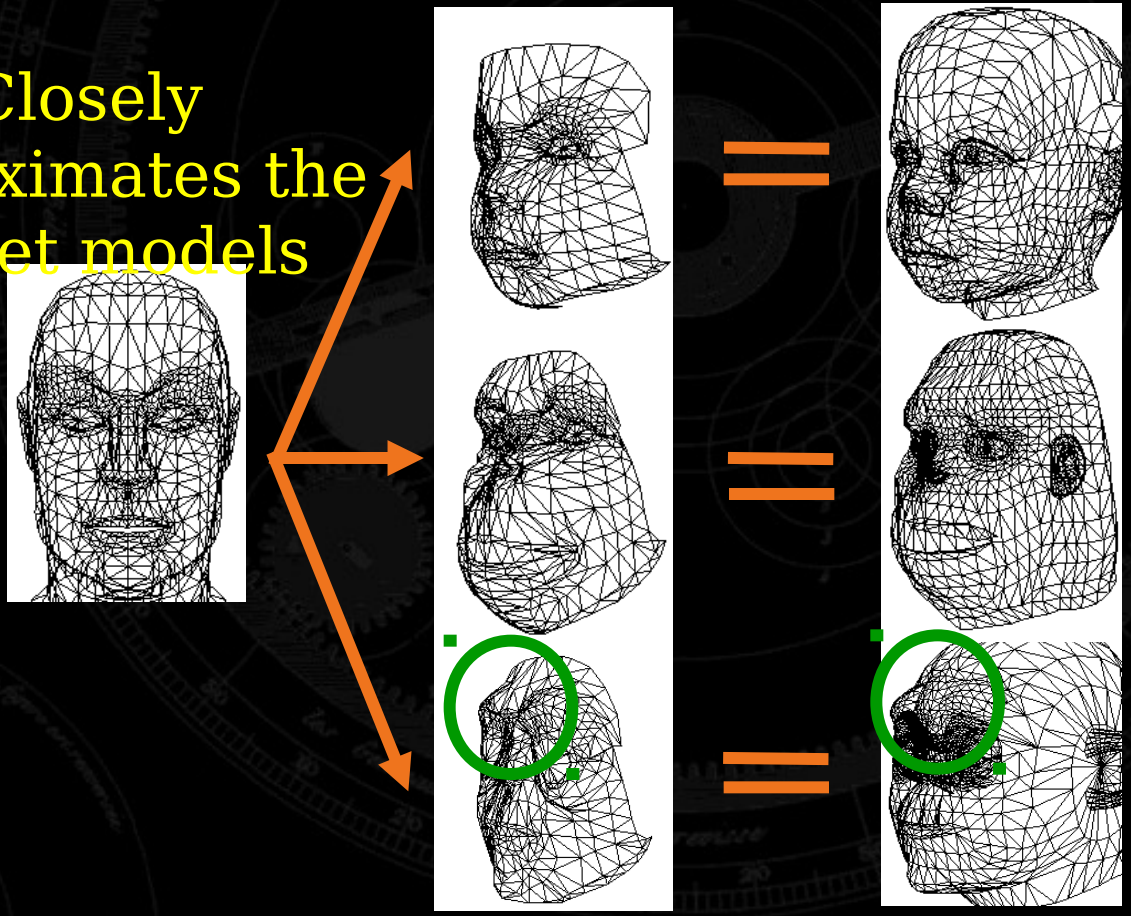
Examples

- Tip of nose: Vertex with highest z value
- Top of head: Vertex with highest y value
- Lip contact line: Set of duplicate vertices



Example Deformed Source Models

Closely approximates the target models



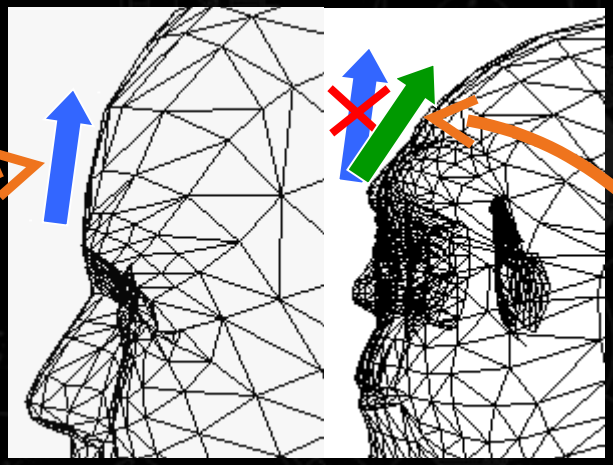
Source

Deformed source

Target

Correct Motion Vector Transfer

- Direction adjustment

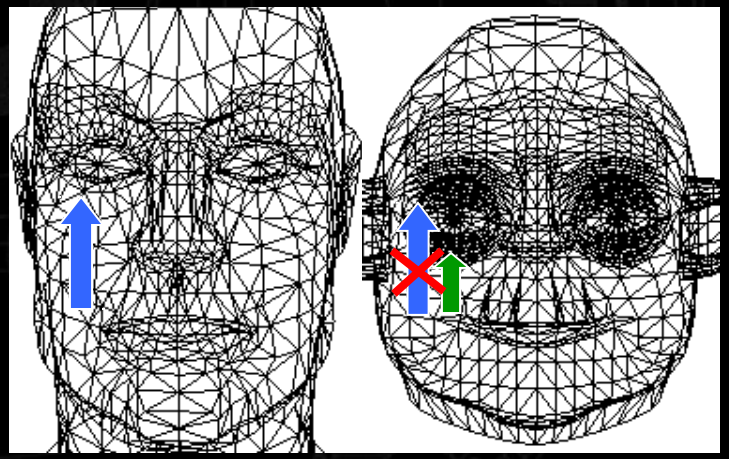


Source Target

Source motion vector

Correct target motion vector

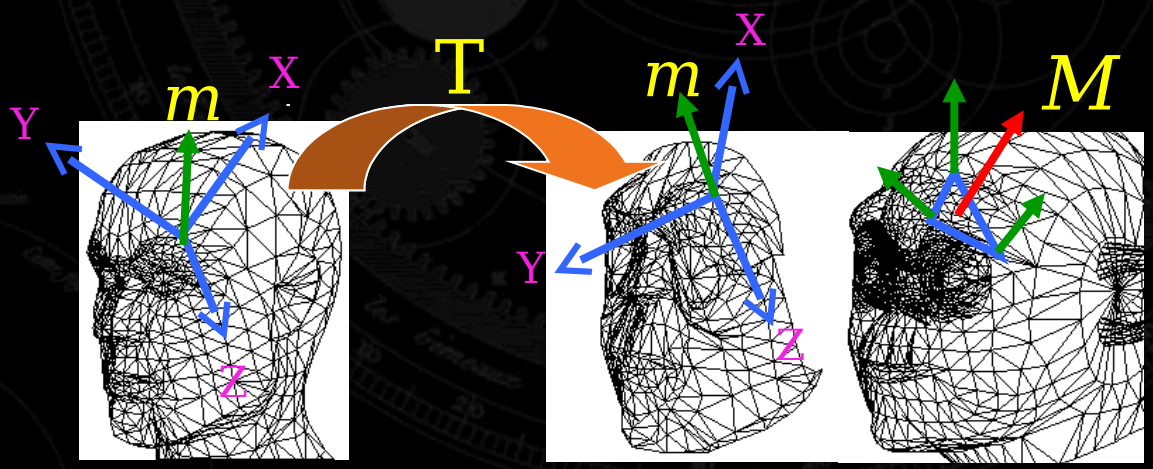
- Magnitude adjustment



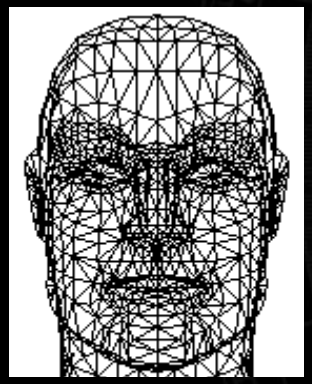
Source Target

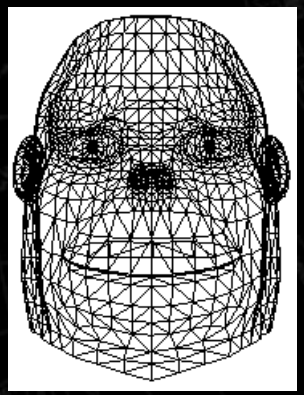
Motion Vector Transfer Steps

- Local coordinate system at each vertex in source and deformed source model
- Transformation between corresponding vertices
- Barycentric coordinates of enclosing triangle

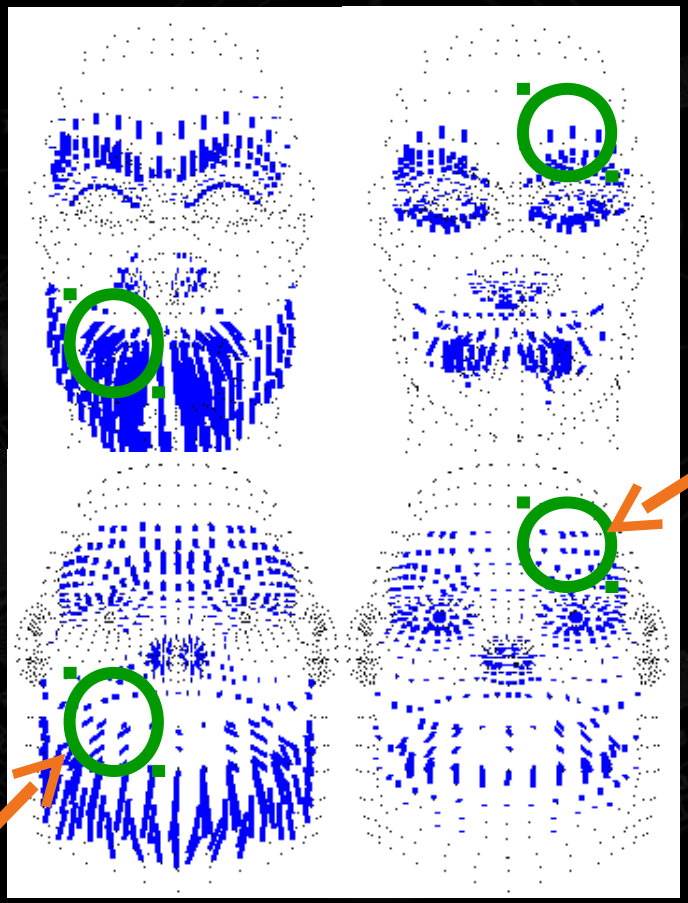


Example Adjusted Motion





Models



Motion vectors

More horizontal

Source

Smaller

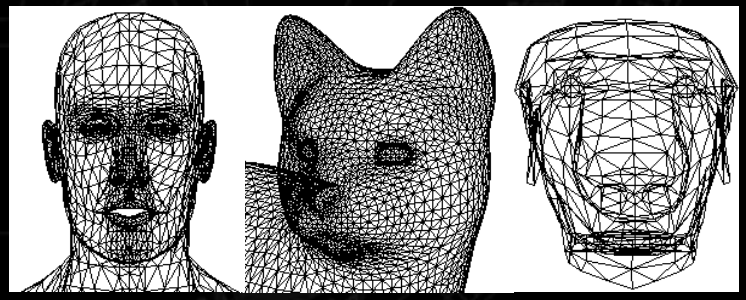
Adjusted motions

Target

Test Model Specifications

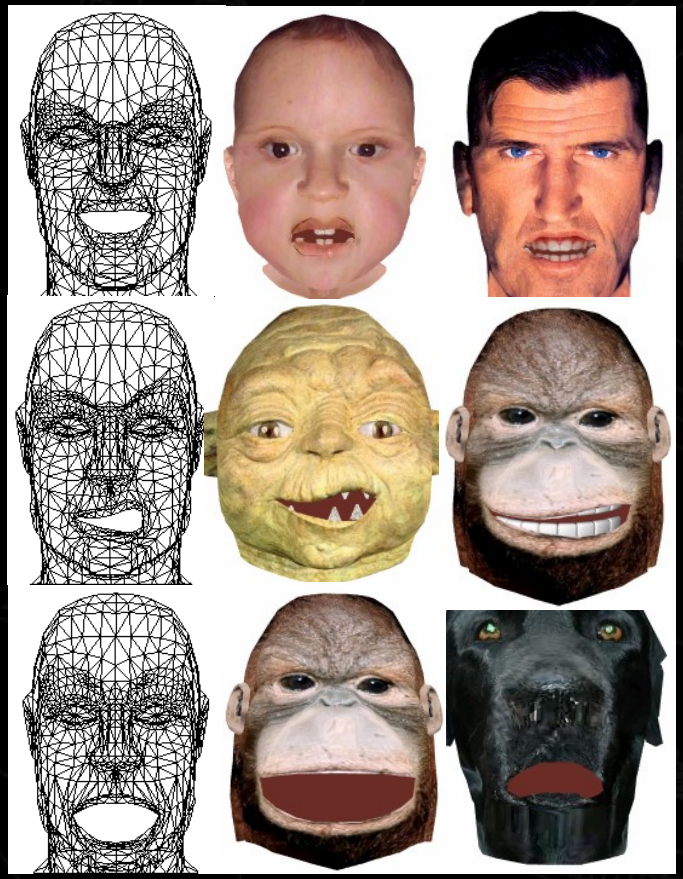
Model	Polygons	Vertices
Source	1954	988
Woman	5416	2859
Man	4314	2227
Yoda	3740	1945
Cat	5405	2801
Monkey	2334	1227
Dog	927	476
Baby	1253	2300

- Different geometric proportions
- Different mesh structures



Man Cat Dog

Example Cloned Expressions



Source

Targets

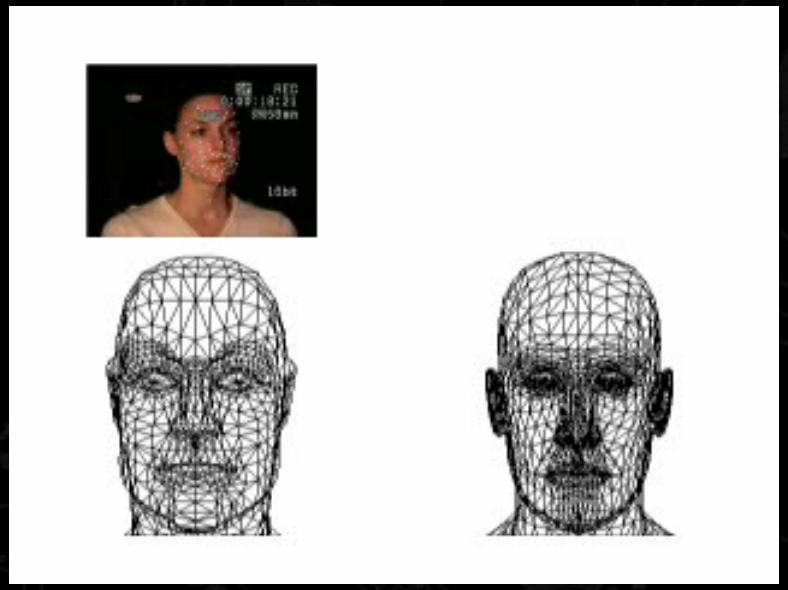
Angry expression

Distorted mouth

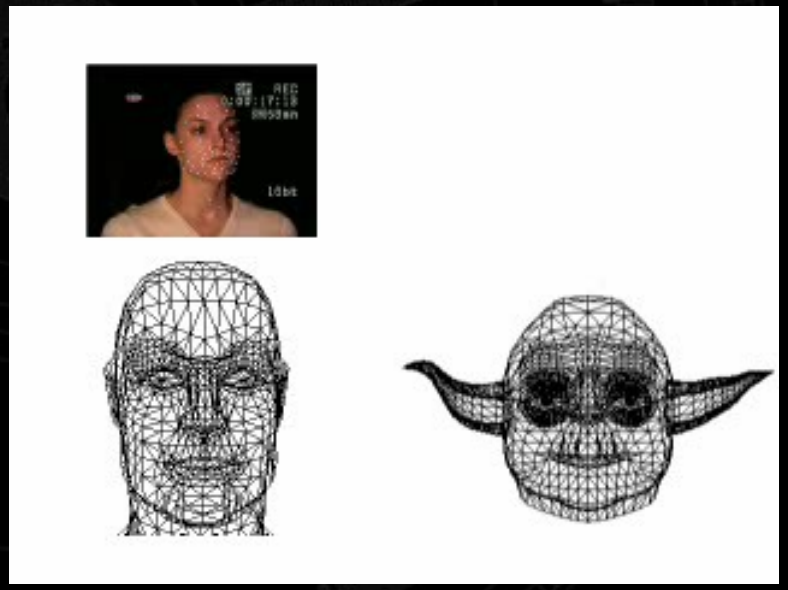
Big open mouth

Expressions are well adapted to a wide variety of models.

Example Cloned Animations



Wire-frame man model



Yoda model

Quantitative Error Measure

- Average position error WRT model size

	Angry	Talking	Smiling	Nervous	Surprised
x	0.22%	0.14%	0.13%	0.14%	0.16%
Y	0.18%	0.26%	0.16%	0.11%	0.12%
Z	0.09%	0.23%	0.06%	0.05%	0.05%

Future Work

- Texture cloning [Liu 2001]

  - color transfer between models

- Texture incorporation [Shinagawa 1998]

  - initial correspondence search

- Control knob [Bruderlin 1995]

  - variations in resulting animation

- Eye blinking, teeth, tongue animation [Stone 1991]

Summary

- Novel alternative to produce facial animation

  - animation transfer between models
- High level control
- Semi-automatic process
- Real time performance on 550MHz PC

Acknowledgement

- NSF through ERC funding of IMSC
- Annenberg center at USC
- DARPA
- Intel HP Motorola
- J.P. Lewis
- Albin Cheenath and Doug Fidaleo (USC)

Thank you

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- noh@usc.edu
- uneumann@usc.edu

Comparison with MPEG-4

Similarities

- Measured motion data
- Animation driven by existing data

Differences

- Easy duplication Vs. Compression
- Dense surface motion Vs. 84 Feature points
- Almost automated Vs. Manual preprocessing

Comparison with PDFA

Similarities

- Measured motion data
- Animation driven by existing data

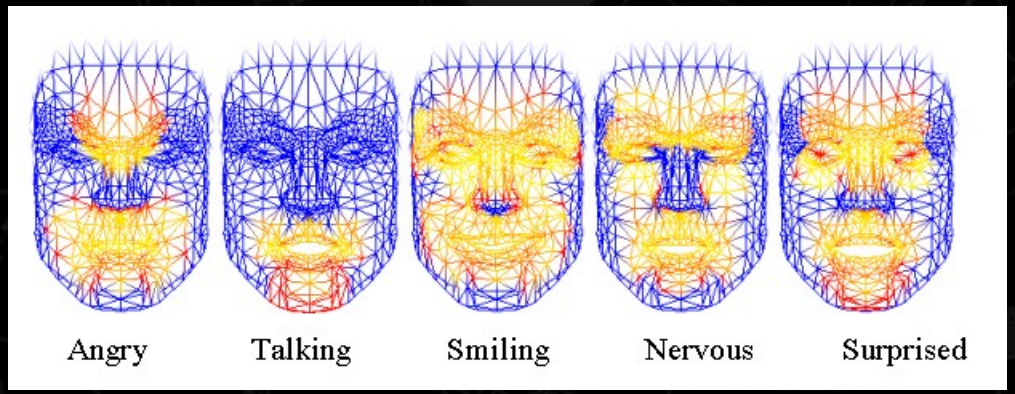
Differences

- Dense surface motion Vs. Sparse feature motions
- Precise 3D data Vs. Guessed animation parameters
- Ground truth data Vs. Error prone tracking data

Quantitative Error Measure

- Average position error WRT motion vector size

Angry	Talking	Smiling	Nervous	Surprised
5.28%	8.56%	4.77%	4.07%	4.56%



No motion

No error

10% error

Quantitative Error Measure

- Average position error WRT model size

	Angry	Talking	Smiling	Nervous	Surprised
x	0.22%	0.14%	0.13%	0.14%	0.16%
Y	0.18%	0.26%	0.16%	0.11%	0.12%
Z	0.09%	0.23%	0.06%	0.05%	0.05%

Quantitative Error Measure

- Average position error WRT motion vector size

Angry	Talking	Smiling	Nervous	Surprised
5.28%	8.56%	4.77%	4.07%	4.56%

- Average position error WRT model size

	Angry	Talking	Smiling	Nervous	Surprised
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Z	0.09%	0.23%	0.06%	0.05%	0.05%